This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1-7. (Canceled)

8. (Previously Presented) A method for producing a heparin polymer *in vitro* comprising the steps of:

-- providing a soluble heparin synthase, wherein the soluble heparin synthase is selected from the group consisting of:

(A) a soluble heparin synthase having an amino acid sequence in accordance with SEQ ID NO:13 or 15;

(B) a soluble heparin synthase encoded by a nucleotide sequence in accordance with SEQ ID NO:12 or 14;

(C) a soluble heparin synthase having an amino acid sequence that is at least 70% identical to at least one of SEQ ID NOS:13 and 15;

(D) a soluble heparin synthase encoded by a nucleotide sequence capable of hybridizing to a complement of at least one of SEQ ID NOS:12 and 14 under hybridization conditions comprising

1.2-1.8 x HPB (High Phosphate Buffer) at 40-50°C, followed by washing in at least one of:

(i) low salt at room temperature for 10-60 minutes, or

(ii) washing in 0.5x - 1x SSC, 1% Sodium dodecyl sulfate at room temperature for 15-30 minutes;

(E) a soluble heparin synthase having an amino acid sequence that is a fragment of at least one of SEQ ID NOS:2, 4, 13 and 15; and

(F) a soluble heparin synthase encoded by a nucleotide sequence comprising a fragment of at least one of SEQ ID NOS:1, 3, 12 and 14;

-- placing the soluble heparin synthase in a reaction mixture containing UDP-GlcNAc and UDP-GlcUA and at least one divalent metal ion suitable for the synthesis of a heparin polymer; and

-- extracting the heparin polymer out of the reaction mixture.

9-18. (Canceled)

19. (Newly Added) A method for enzymatically producing a polymer, comprising the steps of:

-- providing a functional acceptor, wherein the functional acceptor has at least two sugar units selected from the group consisting of uronic acid and hexosamine;

-- providing a soluble heparin/heparosan synthase capable of elongating the functional acceptor, wherein the soluble heparin/heparosan synthase is selected from the group consisting of:

(A) a soluble heparin synthase having an amino acid sequence in accordance with SEQ ID NO:13 or 15;

(B) a soluble heparin synthase encoded by a nucleotide sequence in accordance with SEQ ID NO:12 or 14;

(C) a soluble heparin synthase having an amino acid sequence that is at least 70% identical to at least one of SEQ ID NOS:13 and 15;

(D) a soluble heparin synthase encoded by a nucleotide sequence capable of hybridizing to a complement of at least one of SEQ ID NOS:12 and 14 under hybridization conditions comprising 1.2-1.8 x HPB (High Phosphate Buffer) at 40-50°C, followed by washing in at least one of:

(i) low salt at room temperature for 10-60 minutes, or

(ii) washing in 0.5x - 1x SSC, 1% Sodium dodecyl sulfate at room temperature for 15-30 minutes;

(E) a soluble heparin synthase having an amino acid sequence that is a fragment of at least one of SEQ ID NOS:2, 4, 13 and 15; and

(F) a soluble heparin synthase encoded by a nucleotide sequence comprising a fragment of at least one of SEQ ID NOS:1, 3, 12 and 14;

-- providing at least one of UDP-GlcUA, UDP-GlcNAc and UDP-sugar analogs such that the soluble heparin/heparosan synthase elongates the functional acceptor so as to provide a polymer.

20. (Newly Added) The method of claim 19 wherein, in the step of providing a functional acceptor, uronic acid is further defined as a uronic acid selected from the group consisting of GlcUA, IdoUA, and GalUA.

21. (Newly Added) The method of claim 19 wherein, in the step of providing the functional acceptor, hexosamine is further defined as a hexosamine selected from the group consisting of GlcNAc, GalNAc, GlcN and GalN.

22. (Newly Added) The method of claim 19 wherein, in the step of providing the functional acceptor, the functional acceptor has about three sugar units.

23. (Newly Added) The method of claim 19 wherein, in the step of providing the functional acceptor, the functional acceptor has about four sugar units.